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Spiny hopsage fruit and seed morphology

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Abstract

Rangeland seedings of spiny hopsage (*Grayia spinosa* [Hook.] Moq.) may be made with either bracted utricles or seeds. Problems have resulted from inconsistent use of terminology describing these 2 structures and the fact their germination and seedling emergence is not the same with similar environmental conditions and seeding techniques. We examined the flower, fruit, and seed morphology of spiny hopsage microscopically to resolve these discrepancies and provide a basis for discussing the functional roles of bracted utricle and seed components. The spiny hopsage fruit is a utricle consisting of a single disk-shaped seed contained within a thin pericarp. The utricle is enclosed in 2 papery bracteoles. Failure to recognize the obscure pericarp plus inaccurate use of terminology appear responsible for confusion in the literature. The presence and condition of seed and fruit structures can affect seeding requirements and embryo response to environmental conditions. Consequently, accurate identification of all structures associated with the fruit or seed combined with a review of seed biology and seedling establishment literature is essential for designing effective wildland seeding practices.

Key Words: chenopod, diaspore, *Grayia spinosa*, seed germination, utricle

Literature on seed biology and seeding technology is limited for most native species. Appropriate terminology for describing fruit and seed structures should be used to accurately communicate this information, thus maximizing its value. Knowledge of fruit and seed morphology and available information on seed biology can aid in tailoring more effective seeding systems for individual species and ecotypes.

The objectives of this paper are to describe the pistillate flower, fruit, and seed morphology of a chenopod shrub, spiny hopsage (*Grayia spinosa* [Hook.] Moq.); to clarify some confusion in literature describing these structures; and to review the functional roles of spiny hopsage fruit and seed structures relative to designing seeding systems for successfully reestablishing the species.

Problem

Field germination is affected by many factors in addition to microenvironment. The presence and condition of tissues surrounding the embryo can affect its perception of and response to environmental conditions. Thus, proper identification of the structure to be planted is essential. For spiny hopsage, either bracted utricles (diaspores) or threshed seeds may be planted. Since threshing removes the bracts plus the papery pericarp, utricles are not available. Confusion occurs because, in the commercial trade world, both bracted utricles from which debris has been removed and seeds that have been threshed and separated from the pericarp, bracteoles, and other debris are marketed as cleaned seed. In addition, the terms seed and seeding are frequently used by rangeland planting specialists in presentations and literature without specifically identifying the structures being discussed.

Failure to use terminology accurately or to define terms with alternate meanings complicates discussions of rangeland seedings. As discussed by Booth (1988) definitions of the fruit vary from the mature ovary containing 1 or more seeds (Copeland and McDonald 1985) to broader definitions which include the ripened ovary and: any floral parts that may be associated or united with it in the fruiting stage (Esau 1965); all of its accessory parts (Welsh et al. 1987); any other structures that enclose it at maturity (Harrington and Durrell 1957); or any other structures which ripen with it and form a unit with it (Cronquist et al. 1972, Hitchcock and Cronquist 1973). Consequently, mention of the spiny hopsage fruit, without further explanation, does not indicate whether the utricle alone or the utricle and its enveloping bracteoles are being discussed. To reduce confusion, Booth (1988, 1990) encouraged use of the term diaspore to describe the dispersed reproductive unit. Thus, for spiny hopsage, the diaspore is the utricle and its enveloping bracteoles (the bracted utricle).

Further complications result from inconsistent use of terminology used to categorize fruits. The spiny hopsage fruit has been variously defined as a pod, achene, nutlet, utricle, a utricle consisting of or containing a nutlet, and as being 2-winged and formed from bracts (Bidwell and Wooten 1925, Peck 1961, Smith 1974, Kay et al. 1977, Belcher 1985, Stubbendieck et al. 1986). References to fruiting bracts, bracted seed, and sac-like fruits (Munz and Keck 1959, Kay et al. 1977) and failure to observe the obscure pericarp have led some readers to equate the bracteoles with the pericarp of the utricle. Failure to detect the pericarp has also resulted in the seed coat being described as the pericarp. Thus the term utricle, in addition to its proper use, has been used to describe both the bracted utricle and the seed.

Materials and Methods

A description of spiny hopsage flower, fruit, seed, and embryo morphology has been prepared using observations made during our work with this species, taxonomic descriptions, and a review

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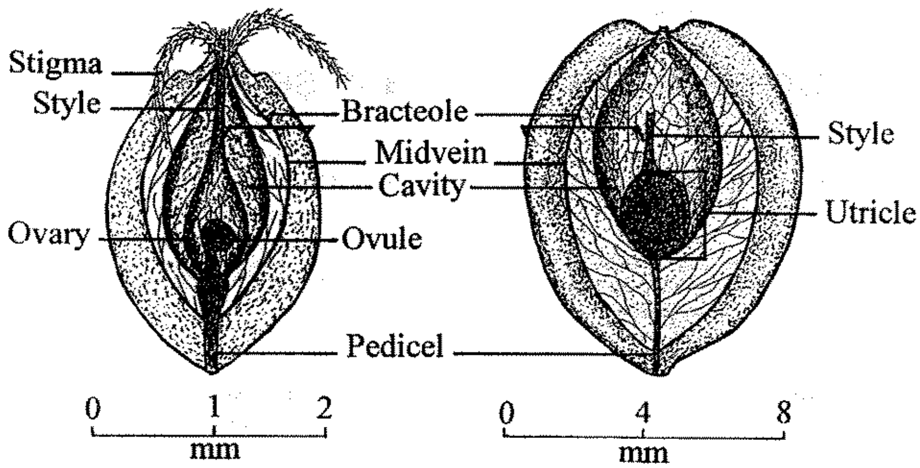

Fig. 1. Drawing of spiny hopsage flower (left) and utricle (right), each enclosed in bracteoles. Note differences in scale between the 2 drawings.

of chenopod seed anatomy (Moquin-Tandon 1849, Hitchcock et al. 1964, Esau 1965). Mature fruits were hand harvested at Sponge Springs, Malheur Co., Ore. (43°48'N 117°26'W) in June 1988, air dried, and stored in sealed containers at room temperature. Flowers and developing fruits were collected at Reynolds Creek, Owyhee County, Ida. (43°16'N 116°43'W) from March to June 1992. Photographs and drawings were made using a stereoscopic zoom microscope with camera and drawing tube attachments. Fruits and seeds were imbibed in distilled water for 24 hours prior to dissection. Tissue viability was examined using tetrazolium staining techniques (Grabe 1970).

Results

Spiny hopsage is generally dioecious. Pistillate flowers develop in dense, terminal spicate inflorescences. Each flower consists of a unilocular ovary with a single persistent style bearing 2 or 3 stigmas (Fig. 1). The perianth is lacking. A single ovule develops within the ovary.

Each pistillate flower is enclosed in 2 small bracts or bracteoles that are folded along their midribs and united along their margins except for a minute apical opening. The thin, papery bracteoles form an elliptic to cordate sac that is strongly flattened except for a bladder-like cavity that surrounds the ovary. Wings containing a thick, spongy layer of hygroscopic cells develop along the margins of the sac from the midvein of each bracteole. Pedicel elongation during flowering and fruiting maintains the developing ovary near the center of the expanding bracteoles; degree of pedicel elongation and resulting placement of the mature fruit, however, are highly variable. Mature bracteole sacs, including the wings, are 6–15 mm in diameter. They sometimes turn pink or red when nearly mature, drying to white, green, or straw-colored. Varying percentages of the bracteoles may be empty or contain withered flowers or aborted fruits.

The fruit is a compressed utricle (Fig. 1). The ovary wall develops into a thin, papery, translucent fruit wall or pericarp similar in texture to the bracteoles and difficult to distinguish from them without magnification. As defined by Hitchcock and Cronquist (1973), the utricle is a small, thin-walled, 1-seeded, more or less

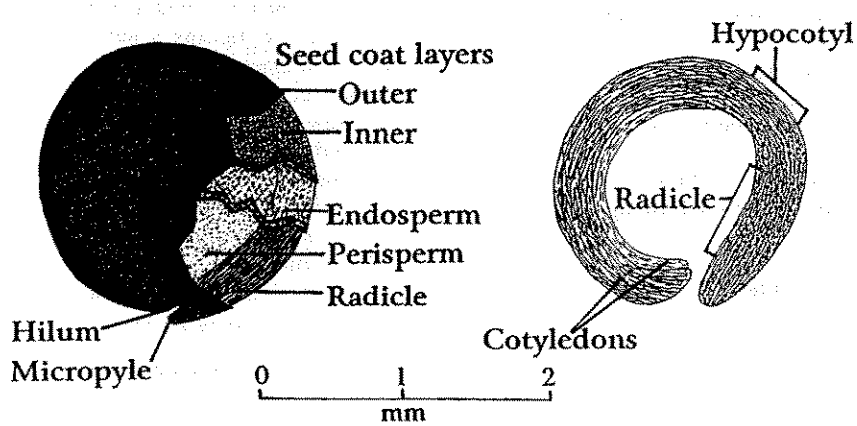

Fig. 2. Drawing of threshed, imbibed spiny hopsage seed with portions of the seed coat layers removed (left) and imbibed, excised embryo (right).

inflated fruit. When dry, the pericarp adheres to the seed coat; following imbibition the pericarp is easily peeled away.

The disk-shaped seed is about 2 mm in diameter (Fig. 2). The smooth, outer, dark-brown layer of the seed coat often ruptures during imbibition. The light-brown inner layer and translucent, living endosperm, however, are elastic and become distended during imbibition. In germinating seeds, these layers are disrupted by radicle extension (Shaw 1992). Cleaning techniques that scarify or rupture the seedcoat enhance germination of some otherwise nongerminable seeds, but excessive treatments may damage the vulnerable radicle tip (Shaw 1992).

The ring-shaped embryo (Fig. 2) consists of yellowish cotyledons that green rapidly on imbibition and exposure to light and an embryonic axis composed of the hypocotyl and radicle. The embryo is ring-shaped, consequently the hilum or basal attachment point of the seed is adjacent to the micropyle, the opening at the apex of the ovule. The embryo encircles a disk of starchy, mealy, nonliving, white perisperm, the major storage tissue of chenopod seeds.

Discussion

Woody and herbaceous species representing taxonomically diverse plant families are currently used in rangeland plantings. The number of species employed is likely to grow due to increasing emphasis on ecosystem management and the conservation of biodiversity. Species currently planted exhibit wide variation in flower, fruit, seed, and embryo morphology.

Tissue layers surrounding the embryo can play important roles in regulating seed dormancy and germination (Bewley and Black 1984, Copeland and McDonald 1985, Booth 1990). Harvesting and conditioning procedures and germination pretreatments may alter or remove some of these tissues. Thus, fruit or seed condition must be carefully appraised when determining appropriate planting technology, including such factors as seeding method, planting date, and planting depth, for individual species and ecotypes. Consequently, an understanding of morphological terms is essential in all discussions of seed biology and technology.

The importance of understanding what structures one is planting can be illustrated with the following examples. Percentage pure live seed may differ greatly for bracted utricles and seeds as many bracteole sacs are empty or contain poorly developed seeds that are not easily removed during cleaning. Bulk is considerably greater for bracted utricles, while purity and viability are generally greater for threshed seeds. Thus, one needs to consider requirements to reduce clogging of seed tubes with bracted utricles, and the addition of a diluent to aid in planting the proper density of seeds. Shaw (1992) reported that under favorable conditions for germination, prechilling enhanced germination of seeds compared with bracted utricles from southwestern Idaho and southeastern Oregon. Shaw (1992) speculated enhancement might be due to improved oxygen uptake by seeds. By contrast, Wood et al. (1976) reported the presence of bracteoles did not affect germination of Nevada and California collections over a wide range of constant and alternating germination temperatures. The presence of bracteoles enhanced germination of bracted utricles compared with seeds at low water potentials. In addition, the presence of bracteoles also appeared to improve seedling emergence of bracted utricles (18%) compared with seeds (0%) when both were broadcast on a rough seedbed (Wood et al. 1976). Emergence was similar for both bracted utricles and seeds when planted 5 mm deep.

The importance of correctly assessing the condition of the structure being planted and matching it with the proper seedbed preparation and seeding practices cannot be overemphasized. Without incorporation of this information into management strategies, many range seedings utilizing spiny hopsage and other species may be doomed from the initiation of the project.

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